Estimating the burden of disease attributable to injecting drug use as a risk factor for HIV, hepatitis C, and hepatitis B: findings from the Global Burden of Disease Study 2013

Louisa Degenhardt, Fiona Charlson, Jeff Stanaway, Sarah Larney, Lily T Alexander, Matthew Hickman, Benjamin Cowie, Wayne D Hall, John Strang, Harvey Whiteford, Theo Vos

Summary

Background **Previous estimates of the burden of HIV, hepatitis B virus (HBV), and hepatitis C virus (HCV) among people who inject drugs have not included estimates of the burden attributable to the consequences of past injecting. We aimed to provide these estimates as part of the Global Burden of Disease (GBD) Study 2013.**

Methods **We modelled the burden of HBV and HCV (including cirrhosis and liver cancer burden) and HIV at the country, regional, and global level. We extracted United Nations data on the proportion of notified HIV cases by transmission route, and estimated the contribution of injecting drug use (IDU) to HBV and HCV disease burden by use of a cohort method that recalibrated individuals' history of IDU, and accumulated risk of HBV and HCV due to IDU. We estimated data on current IDU from a meta-analysis of HBV and HCV incidence among injecting drug users and country-level data on the incidence of HBV and HCV between 1990 and 2013. We calculated estimates of burden of disease through years of life lost (YLL), years of life lived with disability (YLD), deaths, and disability-adjusted life-years (DALYs), with 95% uncertainty intervals (UIs) calculated for each metric.**

Findings **In 2013, an estimated 10·08 million DALYs were attributable to previous exposure to HIV, HBV, and HCV via IDU, a four-times increase since 1990. In total in 2013, IDU was estimated to cause 4·0% (2·82 million DALYs, 95% UI 2·4 million to 3·8 million) of DALYs due to HIV, 1·1% (216 000, 101 000–338 000) of DALYs due to HBV, and 39·1% (7·05 million, 5·88 million to 8·15 million) of DALYs due to HCV. IDU-attributable HIV burden was highest in low-to-middle-income countries, and IDU-attributable HCV burden was highest in high-income countries.**

Interpretation **IDU is a major contributor to the global burden of disease. Effective interventions to prevent and treat these important causes of health burden need to be scaled up.**

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Introduction

The consequences of HIV infection and chronic viral hepatitis—mainly hepatitis B and C—are among the top ten causes of death worldwide.[1] Injecting drug use (IDU) is an important risk factor for all three infections because of sharing of contaminated injecting equipment. The prevalence of HIV among people who inject drugs varies substantially both among and within countries,[2] and tends to be lower where comprehensive harm reduction and prevention strategies have been implemented.[3] In many settings worldwide, more than half of people who inject drugs are infected with hepatitis C virus (HCV).[4] Chronic infection occurs in 75% of HCV infections,[5] and 3–11% of chronic HCV carriers will develop liver cirrhosis within 20 years.[6] Generally, the burden of chronic hepatitis B virus (HBV) is higher among people who were infected as a child, and therefore, the proportion attributable to IDU is lower than that of HCV. A 2011 systematic review estimated that globally, 8% of people currently injecting were HBsAg positive.[4]

The prevalences of IDU and of HIV, HBV, and HCV infection among people who inject drugs[2,4] have been systematically reviewed. We previously estimated the burden of these infections attributable to injection of drugs within the past year.[7] However, no global estimates have been made of the burden attributable to historical IDU and exposure to these viruses. This is an important omission from estimates of burden due to chronic viral hepatitis because the health consequences of progression to chronic infection might not be seen for many decades after initial exposure.

In this Article, we summarise the results of the quantification of this cause of disease burden as part of the Global Burden of Disease Study (GBD) 2013.[8,9] We summarise disease burden as years of life lost (YLL) due to premature mortality, years of life lived with disability (YLDs) in people living with the disorders, and disability-adjusted life-years (DALYs). We estimated the global burden of disease (YLDs, YLLs, and DALYs) attributable to IDU as a risk factor for HIV, HBV, and HCV infection, and examine trends between 1990 and 2013; compare the

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National Drug and Alcohol Research Centre, University of New South Wales Australia, Sydney, NSW, Australia (Prof L Degenhardt PhD, S Larney PhD); **Policy and Evaluation Group, Queensland Centre for Mental Health Research, Brisbane, QLD, Australia** (F Charlson PhD, Prof H Whiteford PhD); **School of Population Health** (F Charlson, Prof H Whiteford) **and Centre for Youth Substance Abuse Research** (Prof W D Hall PhD), **University of Queensland, Brisbane, QLD, Australia; Institute for Health Metrics and Evaluation, University of Washington, Seattle, WA, USA** (J Stanaway PhD, L T Alexander BA, Prof T Vos PhD); **School of Social and Community Medicine, University of Bristol, Bristol, UK** (Prof M Hickman PhD); **Doherty Institute, University of Melbourne, Melbourne, VIC, Australia** (B Cowie PhD); **and National Addiction Centre, King's College London, London, UK** (Prof W D Hall, Prof J Strang MD)

Correspondence to: Prof Louisa Degenhardt, National Drug and Alcohol Research Centre, University of New South Wales Australia, Sydney, NSW 2052, Australia **l.degenhardt@unsw.edu.au**

Research in context

Evidence before this study

On Aug 4, 2016, we searched PubMed for "substance abuse, intravenous/epidemiology or substance-related disorders/epidemiology" [MeSH] AND (burden OR DALY OR QALY OR HALE OR YLL OR YLD) AND (HIV OR HBV OR HCV OR "hepatitis C" OR "hepatitis B"), with no restrictions on language or date of publication, and found 206 publications. We excluded any studies that did not report original estimates of the frequency or burden of disease related to HIV, hepatitis B, or hepatitis C, that were not restricted to people who inject drugs, or that did not produce estimates for an area larger than a country. Only one article met our search criteria: an analysis of the burden of HIV, hepatitis B, and hepatitis C due to past-year injecting drug use, which was reported by our group from the Global Burden of Disease Study (GBD) 2010. The 2010 modelling approach meant that only health burden due to injecting in 2010 was captured. These estimates failed to capture any burden in 2010 due to exposure to these viruses via injecting that occurred before 2010. Consequently, hepatitis burden in 2010 due to injecting drug use exposure was seriously underestimated. No studies have reported original estimates of the total burden of HIV, hepatitis B, or hepatitis C in people who inject drugs, and no studies have reported global estimates of a comprehensive health gap metric (ie, disability-adjusted life-years or quality-adjusted life-years).

Added value of this study

We used data from GBD 2013 to estimate morbidity and mortality among people who inject drugs attributable to HIV, acute hepatitis B and C; and for cirrhosis and liver cancer due to hepatitis B virus (HBV), and hepatitis C virus (HCV) infection. We did so by sex, region, and country from 1990 to 2013. Previous global reviews have reported the prevalence of HIV, hepatitis B surface antigen, and anti-HCV among active injecting drug users, but no study has examined the health burden in this population that results from historical exposure to these viruses via injecting and the later health effects of chronic infection. This historical exposure is especially important for HCV, for which the health burden largely occurs decades after infection. To our knowledge, our study is the first attempt to estimate trends over time in the total burden of HIV, hepatitis B, and hepatitis C among people who inject drugs, using systematic data gathering and robust statistical methods. The burden of hepatitis C among people who inject drugs (jointly considering acute HCV infection, cirrhosis, and liver cancer) is much larger than that of HIV.

Implications of all the available evidence

The health consequences of HIV and viral hepatitis attributable to injecting drug use are major causes of premature death and disability worldwide. Injecting drug use is the cause of a substantial proportion of global HCV burden. These data are crucial to underpin new global efforts to tackle viral hepatitis and HIV.

relative contribution of HIV, HBV, and HCV to total blood-borne virus burden attributed to IDU (YLDs, YLLs, and DALYs); and examine geographic variations in burden of disease attributable to IDU.

Methods

Overview

As part of GBD 2013, we measured the burden of hepatitis B and hepatitis C (including attributable cirrhosis and liver cancer) and HIV at the country, regional, and global level for each age–sex group for 1990–2013. These methods have been described in previous studies.[1,8–11]

Two of the key modelling approaches used in this exercise were Cause of Death Ensemble modelling (CODEm), an analytical tool that explores a variety of models to estimate trends in causes of death,[12] and a disease epidemiology modelling approach that used an age-integrating Bayesian hierarchical model (DisMod-MR 2.0). These approaches have been described in full previously.[1,8–10,12] For HIV, hepatitis B, and hepatitis C, we used disease-specific natural history models to estimate deaths and YLDs, because the three-state model in DisMod-MR 2.0 (susceptible, cases, dead) did not capture the complexity of the disease processes.

Mortality estimation

We used CODEm[12] to model mortality due to overall acute hepatitis based on vital registration data. Because of poor coverage of cause of death data for each of the varieties of acute hepatitis, we used four natural history models for hepatitis B and C to estimate mortality by deriving incidence from measurements of seroprevalence and multiplying this incidence by case fatality to estimate the number of deaths. These four models were then made to fit the parent cause-of-death model.

We estimated HIV mortality using a modified UNAIDS Spectrum model.[9] This is a compartmental HIV progression model that generates age-specific incidence, prevalence, and death rates by use of methods described in detail previously.[9] This modelling approach was modified based on epidemic type. For concentrated epidemics (ie, in which HIV might be prevalent among some subpopulations, such as sex workers, people who inject drugs, or men who have sex with men, but has not spread widely to the general community), the Spectrum models were calibrated to align with vital registration data after correction for misclassification of deaths due to HIV. For generalised HIV epidemics (ie, in which HIV is established in the general population), we minimised a loss function to select the epidemic curves that were

most consistent with the prevalence and all-cause mortality data.[9]

The major burden of mortality from viral hepatitis is caused by cirrhosis and liver cancer resulting from chronic hepatitis infection. We modelled cirrhosis mortality based mainly on vital registration data using CODEm. We used aetiological proportion models estimated with DisMod-MR 2.0 to split the parent cirrhosis estimates into cases of cirrhosis attributable to HBV, HCV, alcohol, and other causes.[1,8–11]

We modelled liver cancer mortality using cancer registry data. These data were transformed into mortality estimates with mortality-to-incidence ratios. The mortality estimates from cancer registries were then added to vital registration system data and the final mortality estimates for liver cancer were generated with CODEm. Aetiological proportions for liver cancer due to HBV, HCV, alcohol, and other causes were generated with DisMod-MR 2.0.

Estimation of YLDs

For non-fatal burden of disease, we estimated the incidence of HBV and HCV infection using seroprevalence data in DisMod-MR 2.0 (full details have already been reported previously).[11,13] For hepatitis B, we used data on the seroprevalence of HBsAg (a marker of chronic infection), excess mortality, and remission to estimate incidence of HBV infection. For HCV, we used data on seroprevalence of HCV antibody (a marker of ever being infected), remission, and mortality to estimate HCV incidence. We also estimated incidence and prevalence of decompensated cirrhosis in DisMod-MR 2.0 using hospital data on cirrhosis (data available from 28 countries, using ICD codes that matched those used for processing cause of death data[1]) and cause-specific mortality rate data. Full details of the modelling process and source data are presented in the Article on GBD 2013 hepatitis burden, including in the appendix.[11]

See Online for appendix

We derived incidence of liver cancer by dividing mortality by the mortality-to-incidence ratios. Mortality-to-incidence ratios were then used to predict liver cancer survival. Finally, we estimated prevalence as a function of incidence and survival by splitting prevalence into four phases. Each phase had different disability weights, which were used to generate YLDs for that phase. Finally, we estimated incidence of HIV using the UNAIDS Spectrum modelling approach.[9]

Burden of HIV attributable to IDU

To estimate the burden of HIV cases attributable to IDU, we extracted data on the proportion of notified HIV

	1990			2013		
	Mean DALYs (95% UI)	Age-standardised DALY rate per 100 000	Population attributable fraction	Mean DALYs (95% UI)	Age-standardised DALY rate per 100 000	Population attributable fraction
Andean Latin America	<500 (<500 to <500)	0·6	1%	1000 (1000–3000)	2·6	1%
Australasia	1000 (1000–1000)	3·8	4%	<500 (<500 to <500)	0·6	4%
Caribbean	5000 (2000–11 000)	15·8	1%	8000 (5000–12 000)	17·0	1%
Central Asia	5000 (1000–16 000)	7·7	59%	69 000 (40 000–104 000)	81·0	64%
Central Europe	2000 (1000–2000)	1·4	15%	7000 (5000–8000)	4·8	23%
Central Latin America	<500 (<500 to <500)	0·2	<1%	1000 (1000–1000)	0·3	<1%
Central sub-Saharan Africa	19 000 (9000–33 000)	52·1	1%	42 000 (29 000–58 000)	60·5	1%
East Asia	1000 (<500–3000)	0·1	29%	171 000 (131 000–233 000)	10·1	26%
Eastern Europe	54 000 (31 000–82 000)	22·8	47%	551 000 (360 000–795 000)	228·3	44%
Eastern sub-Saharan Africa	53 000 (37 000–76 000)	41·2	1%	249 000 (198 000–305 000)	103·2	1%
High-income Asia Pacific	<500 (<500 to <500)	0·0	1%	<500 (<500 to <500)	0·1	1%
High-income North America	137 000 (102 000–175 000)	44·9	9%	49 000 (33 000–68 000)	12·8	10%
North Africa and Middle East	4000 (1000–15 000)	1·8	19%	91 000 (45 000–164 000)	18·0	23%
Oceania	<500 (<500 to <500)	0·8	2%	3000 (1000–7000)	33·9	4%
South Asia	30 000 (9000–68 000)	3·2	1%	37 000 (22 000–58 000)	2·4	1%
Southeast Asia	24 000 (14 000–42 000)	5·9	17%	467 000 (217 000–1 529 000)	71·1	21%
Southern Latin America	3000 (2000–4000)	5·6	7%	6000 (4000–10 000)	9·7	6%
Southern sub-Saharan Africa	4000 (2000–7000)	9·3	1%	220 000 (139 000–312 000)	337·3	1%
Tropical Latin America	15 000 (10 000–22 000)	11·0	4%	22 000 (17 000–29 000)	10·2	5%
Western Europe	61 000 (44 000–84 000)	14·9	9%	26 000 (20 000–34 000)	5·2	10%
Western sub-Saharan Africa	58 000 (35 000–96 000)	41·2	5%	799 000 (633 000–1 000 000)	314·1	6%
Global	478 000 (402 000–565 000)	10·0	3%	2 818 000 (2 385 000–3 811 000)	38·6	4%

Burden is measured by as absolute numbers of DALYs, age-standardised DALY rates, and PAF. Estimates are rounded to the nearest thousand. Uncertainty intervals for DALY rates and PAFs are available in the appendix (pp 104–14). DALY=disability-adjusted life-year.

Table 1: **Burden of disease of HIV attributable to injecting drug use by region, 1990 and 2013**

cases by transmission route from a number of agencies that conduct surveillance of HIV across the world.[14–21] This method of data collection produced 728 datapoints from 81 countries (appendix pp 3–51).

We estimated the proportion of HIV cases attributable to three transmission categories (sexual transmission, IDU, and other) for all country–time periods using DisMod-MR 2.0. The only covariate used in the model was one that added variance to the datapoints derived from data sources that attributed a portion of HIV cases to unknown transmission sources. We scaled the proportions from each of the three transmission models (sexual transmission, IDU, and other) to ensure that they summed to 100% of total HIV transmission by country, year, age, and sex.

Burden of HBV and HCV attributable to IDU

To estimate the relative contribution of IDU to the burden of HBV and HCV disease at the country, regional, and global level, we used a cohort method. We recalibrated individuals according to history of IDU and their accumulated risk of incident HBV and HCV due to IDU. We used data on current IDU, pooled in DisMod-MR 2.0; a meta-analysis of incidence rates of HBV and HCV among people who inject drugs (appendix pp 99, 100); and estimates of population-level incidence of HBV and HCV between 1990 and 2013. We used back extrapolation to estimate incidence before 1990.

To estimate the lifetime risk of being infected with HBV or HCV, we did a cohort analysis for each country, year, age, and sex category and estimated the probability of an individual having been infected in each preceding year. One of the main inputs to this cohort method was the probability of having injected drugs in a specific age cohort in a given calendar year. For example, for a cohort of 40-year-olds in 2015, the relevant probability in 2005 is the estimated prevalence of IDU among 30-year-olds.

In addition to a global time series of estimated prevalence of IDU, we also used the incidence of HBV or HCV and the seroconversion rate of HBV or HCV among people who inject drugs for each age–sex–country–year from 1960 to 2013, by 5-year age groups. Additional details are available in the appendix (pp 51–98).

We modelled the annual incidence rate of HBV and HCV using seroprevalence data in DisMod-MR 2.0. We assumed a low rate of remission (mean 0·015, SE 0·0075)[22] in the HBV model to reflect the small proportion of patients whose infection clears spontaneously. We assumed zero remission for HCV.

	1990			2013		
	Mean DALYs (95% CI)	Age-standardised DALY rate per 100 000	Population attributable fraction (%)	Mean DALYs (95% CI)	Age-standardised DALY rate per 100 000	Population attributable fraction (%)
Andean Latin America	<500 (<500–1000)	1·6	1%	1000 (1000–2000)	3·0	2%
Australasia	<500 (<500 to <500)	1·0	1%	1000 (<500–1000)	1·9	3%
Caribbean	<500 (<500 to <500)	0·5	<1%	<500 (<500–1000)	0·9	1%
Central Asia	1000 (1000–3000)	2·7	<1%	6000 (3000–10 000)	8·6	1%
Central Europe	3000 (1000–6000)	2·2	1%	7000 (3000–11 000)	4·5	3%
Central Latin America	<500 (<500–1000)	0·4	1%	2000 (1000–3000)	1·0	1%
Central sub-Saharan Africa	<500 (<500–1000)	1·1	<1%	1000 (<500–2000)	2·0	1%
East Asia	48 000 (18 000–89 000)	4·8	1%	96 000 (43 000–151 000)	5·6	1%
Eastern Europe	3000 (1000–5000)	1·2	1%	15 000 (6000–25 000)	5·8	4%
Eastern sub-Saharan Africa	1000 (<500–2000)	1·1	<1%	3000 (1000–5000)	1·6	1%
High-income Asia Pacific	4000 (2000–8000)	2·4	1%	8000 (4000–14 000)	3·2	2%
High-income North America	7000 (2000–13 000)	2·3	6%	20 000 (9000–34 000)	4·5	10%
North Africa and Middle East	2000 (1000–3000)	1·0	<1%	6000 (3000–10 000)	1·6	1%
Oceania	<500 (<500 to <500)	5·0	1%	1000 (<500–1000)	9·4	1%
South Asia	2000 (1000–4000)	0·3	<1%	8000 (3000–12 000)	0·5	<1%
Southeast Asia	4000 (2000–8000)	1·3	<1%	16 000 (7000–26 000)	2·7	1%
Southern Latin America	1000 (1000–3000)	3·3	5%	3000 (1000–5000)	4·8	7%
Southern sub-Saharan Africa	<500 (<500–1000)	0·8	<1%	1000 (<500–1000)	1·0	1%
Tropical Latin America	1000 (<500–2000)	0·8	1%	3000 (1000–5000)	1·4	2%
Western Europe	6000 (2000–10 000)	1·3	2%	12 000 (6000–20 000)	2·1	3%
Western sub-Saharan Africa	3000 (1000–5000)	2·3	<1%	7000 (3000–11 000)	3·3	1%
Global	88 000 (35 000–160 000)	2·1	1%	216 000 (101 000–338 000)	3·1	1%

Burden is measured as absolute numbers of DALYs, age-standardised DALY rates, and PAF. Estimates are rounded to the nearest thousand. Uncertainty intervals for DALY rates and PAFs are available in the appendix (pp 104–14). HBV=hepatitis B virus. DALY=disability-adjusted life-year.

Table 2: **Burden of disease of HBV attributable to injecting drug use by region, 1990 and 2013**

We generated pooled incidence rate for viral hepatitis from a meta-analysis of longitudinal epidemiological studies that reported an incidence rate for HBV[23–27] or HCV[23–38] among people who inject drugs (appendix pp 99,100). We calculated confidence intervals for the incidence rate (where no CI was reported) from a Poisson distribution around the number of cases. A meta-analysis was used to pool incidence rates as an input in our modelling strategy.

We excluded studies that focused on subgroups, such as people who had injected recently or adolescents because hepatitis incidence is far higher in those groups than for all people who inject drugs.[39] We did not vary incidence among people actively injecting according to the availability of blood-borne virus prevention strategies (eg, needle and syringe programmes or opioid substitution therapy) because too few studies have examined incidence according to level of coverage and we were not able to estimate coverage by country over time. In any case, coverage in most countries remains very low among people who inject drugs,[40] and would have been negligible in most countries until recent years.

We estimated the prevalence of current IDU using data and estimates from a review by the Reference Group to the UN on HIV and IDU.[2] This review used a multistage process of systematic review that adhered to international guidelines. It involved multiple stages of peer and expert review, with searches of the peer-reviewed literature in addition to an extensive review of online grey literature databases related to drugs, alcohol, and HIV. We also collected additional data on the age and sex distribution of IDU for this modelling exercise (pp 101–03). We used DisMod-MR 2.0 to estimate the prevalence of IDU with year as a covariate to estimate the change in use over time. To project IDU prevalence from the baseline level in 1990 backwards in time to 1960, we took draws from a normal distribution of the coefficient for the year covariate in the DisMod-MR 2.0 model. DisMod-MR 2.0 makes an average estimate of the change in drug use over the time period from 1990 to 2013 and we used this coefficient to extrapolate drug use back to 1960.

Analyses

For all of the inputs, we took 1000 draws to propagate uncertainty around our point estimates. Using each of these components, we calculated a mean population attributable fraction and 95% uncertainty interval (UI) from the 1000 draws for each GBD country, for each year (1990, 1995, 2000, 2005, 2010, and 2013) and 5-year age

	1990			2013		
	Mean DALYs (95% CI)	Age-standardised DALY rate per 100 000	Population attributable fraction (%)	Mean DALYs (95% CI)	Age-standardised DALY rate per 100000	Population attributable fraction (%)
Andean Latin America	9000 (6000–14 000)	33·8	21%	49 000 (36 000–67 000)	103·0	39%
Australasia	6000 (4000–8000)	28·0	38%	21 000 (15 000–27 000)	59·4	59%
Caribbean	9000 (5000–13 000)	30·0	21%	32 000 (24 000–43 000)	73·2	38%
Central Asia	13 000 (7000–20 000)	24·2	10%	73 000 (53 000–100 000)	91·3	25%
Central Europe	86 000 (50 000–123 000)	65·5	30%	153 000 (119 000–193 000)	97·6	52%
Central Latin America	80 000 (48 000–118 000)	66·6	19%	241 000 (188 000–294 000)	109·7	31%
Central Sub-Saharan Africa	6000 (3000–9000)	16·5	9%	39 000 (23 000–56 000)	65·8	19%
East Asia	613 000 (428 000–803 000)	61·9	30%	2 425 000 (1 889 000–2 987 000)	140·5	49%
Eastern Europe	73 000 (41 000–110 000)	30·1	32%	605 000 (478 000–780 000)	231·1	68%
Eastern sub-Saharan Africa	45 000 (27 000–67 000)	39·3	18%	176 000 (131 000–225 000)	83·8	34%
High-income Asia Pacific	133 000 (74 000–208 000)	69·5	23%	373 000 (264 000–527 000)	144·5	46%
High-income North America	259 000 (169 000–346 000)	89·2	60%	810 000 (628 000–1 014 000)	177·2	81%
North Africa and Middle East	49 000 (29 000–74 000)	22·6	4%	119 000 (90 000–152 000)	29·6	7%
Oceania	2000 (1000–3000)	35·8	16%	7000 (4000–13 000)	85·5	28%
South Asia	49 000 (30 000–74 000)	5·5	3%	216 000 (140 000–316 000)	14·6	7%
Southeast Asia	104 000 (54 000–176 000)	30·5	14%	525 000 (357 000–719 000)	85·4	28%
Southern Latin America	47 000 (29 000–64 000)	109·0	56%	112 000 (90 000–135 000)	171·5	70%
Southern sub-Saharan Africa	8000 (4000–14 000)	21·0	19%	14 000 (8000–22 000)	23·2	26%
Tropical Latin America	104 000 (54 000–161 000)	80·1	35%	268 000 (195 000–361 000)	126·4	54%
Western Europe	376 000 (232 000–519 000)	88·3	44%	705 000 (570 000–838 000)	120·1	64%
Western sub-Saharan Africa	23 000 (14 000–37 000)	17·8	7%	84 000 (60 000–113 000)	37·4	11%
Global	2 095 000 (1 438 000–2 694 000)	48·6	23%	7 046 000 (5 882 000–8 153 000)	101·1	38%

Burden is measured as absolute numbers of DALYs, age-standardised DALY rates, and PAF. Estimates are rounded to the nearest thousand. Uncertainty intervals for DALY rates and PAFs are available in the appendix (pp 104–14). HCV=hepatitis C virus. DALY=disability-adjusted life-year.

Table 3: **Burden of disease of HCV attributable to injecting drug use by region, 1990 and 2013**

	Men			Women			All		
	Mean (95% UI)	Age-standardised rate per 100 000	Population attributable fraction (%)	Mean (95% UI)	Age-standardised rate per 100 000	Population attributable fraction	Mean (95% UI)	Age-standardised rate per 100 000	Population attributable fraction (%)
HIV burden									
HIV/AIDS mycobacterial									
DALYs	145 000 (109 000–216 000)	4·0 (3·0–5·9)	5·7% (4·9–7·3)	38 000 (29 000–50 000)	1·0 (0·8–1·4)	2·1% (1·8–2·6)	183 000 (140 000–263 000)	2·5 (1·9–3·6)	4·2% (3·7–5·3)
YLDs	11 000 (6000–20 000)	0·3 (0·2–0·6)	7·0% (5·2–9·0)	2000 (1000–4000)	0·1 (0·0–0·1)	2·2% (1·8–2·7)	14 000 (7000–23 000)	0·2 (0·1–0·3)	5·1% (3·9–6·6)
YLLs	134 000 (99 000–203 000)	3·6 (2·7–5·5)	5·6% (4·7–7·3)	35 000 (27 000–47 000)	1·0 (0·7–1·3)	2·1% (1·8–2·6)	169 000 (128 000–250 000)	2·3 (1·8–3·4)	4·2% (3·6–5·3)
Deaths	3000 (2000–5000)	0·1 (0·1–0·1)	6·3% (5·3–8·1)	1000 (1000–1000)	0·0 (0·0–0·0)	2·4% (2·0–2·9)	4000 (3000–6000)	0·1 (0·0–0·1)	4·7% (4·1–6·0)
HIV/AIDS other									
DALYs	1 948 000 (1 587 000–2 776 000)	53·2 (43·3–76·0)	5·7% (4·9–7·4)	687 000 (574 000–872 000)	18·9 (15·8–24·0)	2·2% (1·9–2·6)	2 635 000 (2 235 000–3 552 000)	36·1 (30·6–48·6)	4·0% (3·5–5·0)
YLDs	125 000 (2000–192 000)	3·5 (2·3–5·3)	6·4% (5·3–8·2)	47 000 (32 000–8000)	1·3 (0·9–1·9)	2·6% (2·2–3·0)	172 000 (116 000–261 000)	2·4 (1·6–3·6)	4·5% (3·9–5·7)
YLLs	1 823 000 (1 488 000–2 606 000)	49·7 (40·5–71·0)	5·7% (4·8–7·4)	639 000 (533 000–813 000)	17·6 (14·7–22·3)	2·2% (1·9–2·6)	2 462 000 (2 086 000–3 314 000)	33·7 (28·5–45·3)	4·0% (3·5–5·0)
Deaths	43 000 (35 000–61 000)	1·2 (1·0–1·7)	6·4% (5·5–8·2)	14 000 (12 000–18 000)	0·4 (0·3–0·5)	2·4% (2·1–2·9)	57 000 (48 000–76 000)	0·8 (0·7–1·1)	4·5% (4·0–5·7)
Total HIV									
DALYs	2 093 000 (1 709 000–2 970 000)	57·2 (46·6–81·3)	5·7% (4·9–7·3)	724 000 (605 000–919 000)	19·9 (16·7–25·3)	2·2% (1·9–2·6)	2 818 000 (2 385 000–3 811 000)	38·6 (32·7–52·2)	4·0% (3·5–5·0)
YLDs	137 000 (91 000–209 000)	3·8 (2·5–5·8)	6·5% (4·9–7·3)	50 000 (34 000–71 000)	1·4 (0·9–2·0)	2·6% (2·1–3·0)	186 000 (127 000–280 000)	2·6 (1·8–3·9)	4·6% (3·9–5·7)
YLLs	1 957 000 (1 600 000–2 779 000)	53·4 (43·6–75·7)	5·7% (4·8–7·3)	675 000 (563 000–861 000)	18·6 (15·5–23·6)	2·2% (1·9–2·6)	2 631 000 (2 224 000–3 554 000)	36·0 (30·5–48·6)	4·0% (3·5–5·0)
Deaths	46 000 (38 000–66 000)	1·3 (1·0–1·8)	6·4% (5·4–8·2)	15 000 (13 000–19 000)	0·4 (0·3–0·5)	2·4% (2·1–2·9)	61 000 (52 000–82 000)	0·8 (0·72–1·1)	4·5% (4·0–5·7)
HBV burden									
Acute HBV infection									
DALYs	13 000 (6000–22 000)	0·4 (0·2–0·6)	0·8% (0·4–1·3)	2000 (1000–4000)	0·1 (0·0–0·1)	0·3% (0·1–0·4)	16 000 (7000–25 000)	0·2 (0·1–0·4)	0·6% (0·3–1·0)
YLDs	1000 (<500–2000)	0·0 (0·0–0·1)	1·2% (0·5–1·8)	<500 (<500–1000)	0·0 (0·0–0·0)	0·5% (0·2–0·7)	2000 (1000–3000)	0·0 (0·0–0·0)	0·9% (0·4–1·4)
YLLs	12 000 (5000–20 000)	0·4 (0·2–0·6)	0·8% (0·4–1·3)	2000 (1000–3000)	0·1 (0·0–0·1)	0·2% (0·1–0·4)	14 000 (6000–23 000)	0·2 (0·1–0·3)	0·6% (0·3–0·9)
Deaths	<500 (<500–1000)	0·0 (0·0–0·0)	0·9% (0·4–1·5)	<500 (<500 to 500)	0·0 (0·0–0·0)	0·3% (0·1–0·5)	<500 (<500–1000)	0·0 (0·0–0·0)	0·7% (0·3–1·1)
Liver cancer									
DALYs	92 000 (44 000–146 000)	2·7 (1·3–4·3)	1·4% (0·6–2·1)	9000 (4000–14 000)	0·3 (0·1–0·4)	0·5% (0·2–0·8)	101 000 (48 000–160 000)	1·5 (0·7–2·3)	1·2% (0·5–1·8)
YLDs	1000 (<500–1000)	0·0 (0·0–0·0)	1·4% (0·6–2·2)	<500 (<500 to 500)	0·0 (0·0–0·0)	0·5% (0·2–0·8)	1000 (<500–1000)	0 (0·0–0·0)	1·2% (0·5–1·9)
YLLs	91 000 (43 000–145 000)	2·7 (1·3–4·3)	1·4% (0·6–2·1)	9000 (4000–14 000)	0·3 (0·1–0·4)	0·5% (0·2–0·8)	100 000 (47 000–159 000)	1·5 (0·7–2·3)	1·2% (0·5–1·8)
Deaths	3000 (1000–5000)	0·1 (0·0–0·2)	1·3% (6·0–2·0)	<500 (<500–1000)	0·0 (0·0–0·0)	0·5% (0·2–0·7)	3000 (2000–5000)	0·1 (0·0–0·1)	1·1% (0·5–1·7)
Liver cirrhosis									
DALYs	81 000 (36 000–128 000)	2·3 (1·1–3·7)	1·3% (0·6–2·0)	18 000 (8000–29 000)	0·5 (0·2–0·8)	0·6% (0·3–1·0)	99 000 (44 000–157 000)	1·4 (0·6–2·2)	1·0% (0·5–1·6)
YLDs	1000 (<500–2000)	0·0 (0·0–0·1)	1·3% (0·6–2·1)	<500 (<500–1000)	0·0 (0·0–0·0)	0·7% (0·3–1·1)	2000 (1000–3000)	0·0 (0·0–0·0)	1·1% (0·5–1·7)

(Table 4 continues on next page)

	Men			Women			All		
	Mean (95% UI)	Age-standardised rate per 100 000	Population attributable fraction (%)	Mean (95% UI)	Age-standardised rate per 100 000	Population attributable fraction (%)	Mean (95% UI)	Age-standardised rate per 100 000	Population attributable fraction (%)
(Continued from previous page)									
YLLs	80 000 (36 000–126 000)	2·3 (1·0–3·7)	1·3% (0·6–2·0)	18 000 (8000–28 000)	0·5 (0·2–0·8)	0·6% (0·3–1·0)	97 000 (44 000–155 000)	1·4 (0·6–2·2)	1·0% (0·5–1·6)
Deaths	2000 (1000–4000)	0·1 (0·0–0·1)	1·2% (0·5–1·9)	1000 (<500–1000)	0·0 (0·0–0·0)	0·5% (0·2–0·9)	3000 (1000–5000)	0 (0·0–0·1)	0·9% (0·4–1·5)
Total HBV									
DALYs	187 000 (87 000–292 000)	5·4 (2·5–8·6)	1·3% (0·6–1·9)	29 000 (13 000–46 000)	0·8 (0·4–1·3)	0·5% (0·2–0·8)	216 000 (101 000–338 000)	3·1 (1·5–4·9)	1·0% (0·5–1·6)
YLDs	3000 (1000–5000)	0·1 (0·0–0·2)	1·3% (0·6–2·0)	1000 (<500–1000)	0·0 (0·0–0·0)	0·5% (0·2–0·9)	4000 (2000–7000)	0·1 (0·0–0·1)	1·0% (0·5–1·6)
YLLs	183 000 (85 000–288 000)	5·4 (2·5–8·5)	1·3% (0·6–1·9)	28 000 (13 000–45 000)	0·8 (0·4–1·3)	0·5% (0·2–0·8)	212 000 (99 000–332 000)	3·1 (1·4–4·8)	1·0% (0·5–1·6)
Deaths	6000 (3000–9000)	0·2 (0·1–0·3)	1·2% (0·5–1·9)	1000 (<500–2000)	0·0 (0·0–0·1)	0·5% (0·2–0·8)	7000 (3000–11 000)	0·1 (0·0–0·2)	1·0% (0·4–1·6)
HCV burden									
Acute HCV infection									
DALYs	25 000 (7000–56 000)	0·7 (0·2–1·5)	28·8% (22·6–35·3)	6000 (2000–13 000)	0·2 (0·1–0·4)	13·1% (10–16·7)	32 000 (10 000–68 000)	0·4 (0·1–0·9)	23·0% (18·6–27·6)
YLDs	3000 (2000–4000)	0·1 (0·0–0·1)	29·8% (24·9–34·2)	1000 (1000–2000)	0·0 (0·0–0·1)	15·4% (12·1–18·5)	4000 (2000–6000)	0·1 (0·0–0·1)	23·1% (19–26·8)
YLLs	22 000 (5000–53 000)	0·6 (0·1–1·5)	28·8% (22–36·1)	5000 (1000–12 000)	0·1 (0·0–0·3)	12·6% (9·6–16·5)	28 000 (6000–64 000)	0·4 (0·1–0·9)	23·0% (18·4–28·2)
Deaths	1000 (<500–1000)	0·0 (0·0–0·0)	28·5% (22–35·9)	<500 (<500 to 500)	0·0 (0·0–0·0)	10·7% (8·0–13·8)	1000 (<500–2000)	0·0 (0·0–0·0)	21·4% (17·1–25·9)
Liver cancer									
DALYs	2 771 000 (2 154 000–3 355 000)	82·1 (63·7–99·7)	47·7% (39·8–54·4)	418 000 (323 000–523 000)	12·1 (9·3–15·1)	19·3% (15·0–23·4)	3 189 000 (2 489 000–3 835 000)	46·4 (36·2–55·9)	40·0% (32·9–46)
YLDs	22 000 (14 000–32 000)	0·7 (0·4–1·0)	43·3% (35·4–50·4)	4000 (2000–6000)	0·1 (0·1–0·2)	16·2% (12·1–20·2)	26 000 (17 000–37 000)	0·4 (0·3–0·6)	34·8% (27·8–40·9)
YLLs	2 749 000 (2 132 000–3 331 000)	81·4 (63·1–99·0)	47·8% (39·8–54·5)	414 000 (320 000–518 000)	12·0 (9·2–15)	19·3% (15–23·5)	3 163 000 (2 467 000–3 806 000)	46·0 (35·9–55·4)	40·0% (33–46·1)
Deaths	93 000 (72 000–113 000)	2·9 (2·2–3·6)	39·6% (32·2–46·3)	16 000 (12 000–21 000)	0·5 (0·4–0·6)	14·9% (11·1–18·6)	109 000 (84 000–132 000)	1·7 1·7 (1·3–2·0)	31·7% (25·1–37·5)
Liver cirrhosis									
DALYs	2 902 000 (2 490 000–3 364 000)	83·2 (71–96·6)	47·3% (40·3–53·4)	924 000 (744 000–1 114 000)	26·0 (20·9–31·5)	24·4% (19·7–29·2)	3 826 000 (3 264 000–4 441 000)	54·3 (46·1–63·2)	38·5% (32·7–43·5)
YLDs	43 000 (29 000–61 000)	1·2 (0·8–1·7)	49·9% (43·1–56)	16 000 (11 000–23 000)	0·5 (0·3–0·7)	49·9% (43·1–56)	59 000 (40 000–83 000)	0·8 (0·6–1·2)	40·8% (35–45·9)
YLLs	2 859 000 (2 450 000–3 317 000)	81·9 (69·9–95·4)	47·2% (40·2–53·4)	908 000 (732 000–1 095 000)	25·6 (20·6–30·9)	24·4% (19·6–29·2)	3 767 000 (3 209 000–4 372 000)	53·5 (45·3–62·3)	38·5% (32·7–43·4)
Deaths	86 000 (72 000–100 000)	2·6 (2·2–3·1)	41·6% (34·8–47·7)	29 000 (22 000–35 000)	0·8 (0·6–1·0)	19·0% (14·7–23·4)	114 000 (95 000–135 000)	54·3 (46·1–63·2)	32·0% (26·7–36·9)
Total HCV									
DALYs	5 698 000 (4 754 000–6 588 000)	165·9 (138·1–192·8)	47·3% (40–53·3)	1 348 000 (1 081 000–1 609 000)	38·3 (30·6–45·8)	22·5% (18·1–26·7)	7 046 000 (5 882 000–8 153 000)	101·1 (83·9–117·3)	39·1% (31·4–42·7)
YLDs	68 000 (46 000–93 000)	2·0 (1·4–2·7)	46·3% (39·6–52·2)	21 000 (14 000–30 000)	0·6 (0·4–0·8)	23·5% (19·1–27·9)	89 000 (61 000–123 000)	1·3 (0·9–1·8)	37·6% (30·4–41·2)
YLLs	5 630 000 (4 697 000–6 505 000)	163·9 (136·4–190·5)	47·4% (40·0–53·3)	1 327 000 (1 064 000–1 586 000)	37·7 (30·2–45·1)	22·4% (18·1–26·7)	6 957 000 (5 806 000–8 048 000)	99·8 (82·7–115·8)	39·1% (31·4–42·7)
Deaths	179 000 (146 000–211 000)	5·5 (4·5–6·6)	40·5% (33·6–46·7)	45 000 (35 000–56 000)	1·3 (1·0–1·6)	17·2% (13·3–21·3)	224 000 (182 000–264 000)	3·3 (2·7–4·0)	31·8% (24·3–35·2)

Burden was measured as DALYs, YLDs, YLLs, and deaths. HBV=hepatitis B virus. HCV=hepatitis C virus. DALY=disability-adjusted life-year. YLD=years of life lived with disability. YLL=years of life lost. PAF=population attributable fraction.

Table 4: **Burden of disease attributable to injecting drug use by outcome and sex, 2013**

group. Where we report rates of DALYs, YLLs, YLDs, or deaths by country or region, we used the revised GBD 2013 world population standard for the age-standardisation of these rates. Details of the age-standard and its development have been reported previously.[1]

Role of the funding source

The funder of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report. The corresponding author had full access to all the data in the study and had final responsibility for the decision to submit for publication.

Results

Globally, the number of DALYs attributable to IDU for HIV (table 1), HBV (table 2), and HCV (table 3) nearly quadrupled between 1990 and 2013, from 2 661 000 to 10 080 000 (appendix pp 104–14 for UIs around estimates of age-standardised DALY rates and population attributable fractions in these tables). The contribution

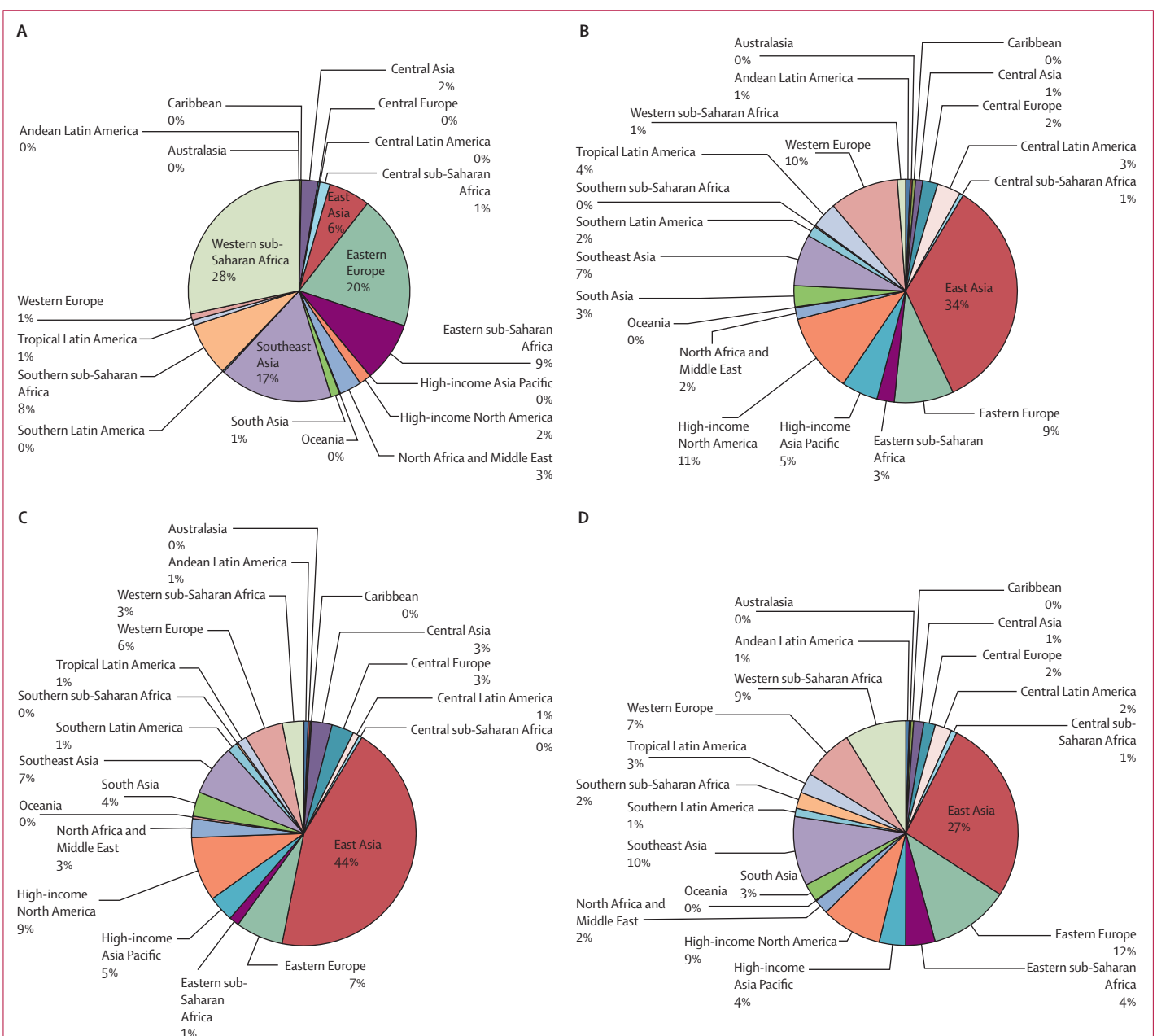

Figure 1: **Distribution of absolute DALYs attributable to injecting drug use, 2013**
DALYs attributable to injecting drug are for HIV (A), hepatitis C virus (B), hepatitis B virus (C), and HIV, hepatitis C virus, and hepatitis B virus combined (D). DALY=disability-adjusted life-year.

that injecting made to these causes of disease burden over time varied substantially across regions in (tables 1–3; appendix pp 104–14 for UIs).

Viral hepatitis arising from IDU was a far bigger contributor to disease burden than was HIV in both 1990 and 2013. HCV was the largest contributor to the burden of IDU by a substantial margin (table 3), accounting for 7·05 million DALYs (95% UI 5·88 million to 8·15 million) in 2013. Almost all HCV-related burden attributed to IDU was from liver cirrhosis (3·83 million DALYs globally, 95% UI 3·26 million to 4·44 million) and liver cancer (3·19 million DALYs, 95% UI 2·49 million to 3·84 million; table 4) By comparison, there were 2·82 million DALYs (95% UI 2·39 million to 3·81 million) for all HIV outcomes attributable to IDU and 0·22 million DALYs (95% UI 0·10 million to 0·34 million) for all HBV outcomes attributable to IDU. Most of the disease burden attributable to IDU was due to YLLs rather than YLDs. In 2013, IDU was estimated to cause 4·0% (2·82 million, 95% UI 2·4 million to 3·8 million) of total DALYs due to HIV, 1·1% (216 000, 101 000–338 000) of total DALYs due to HBV, and 39·1% (7·05 million; 5·88 million to 8·15 million) of total DALYs due to HCV.

Figure 1 shows the distribution of DALYs due to HBV, HCV, and HIV attributable to IDU, by GBD region. The regions differed noticeably in their contributions to the global burden of each blood-borne viral infection. For example, we estimated that regions in Asia jointly accounted for nearly two-thirds of global HBV burden (62%) and half of the global HCV (50%) burden attributable to IDU. The contribution to global burden was particularly high in east Asia, which had 44% of total HBV burden and 34% of total HCV burden. By contrast, these regions accounted for only 26% of global IDU-attributable HIV burden. Regions in sub-Saharan Africa accounted for 46% of IDU-attributable HIV burden, but had much smaller proportions of IDU-attributable HBV and HCV (both 5%). High-income North America was estimated to account for roughly a tenth of global IDU-attributable HCV (11%) and HBV burden (9%), but only 2% of HIV burden attributable to IDU. In terms of IDU-attributable burden, eastern Europe accounted for an estimated 20% of HIV burden, 9% of HCV burden, and 7% of HBV burden (table 3, figure 1; appendix p 105).

Table 4 also provides global estimates of burden due to specific consequences of HIV, HBV, and HCV infection in 2013 by sex. The IDU-attributable burden of infection was higher in men than in women for consequences of all three infections (table 4). At the global level, IDU in men was the cause of 5·7% of HIV DALYs, 47·3% of HCV DALYs, and 1·3% of HBV

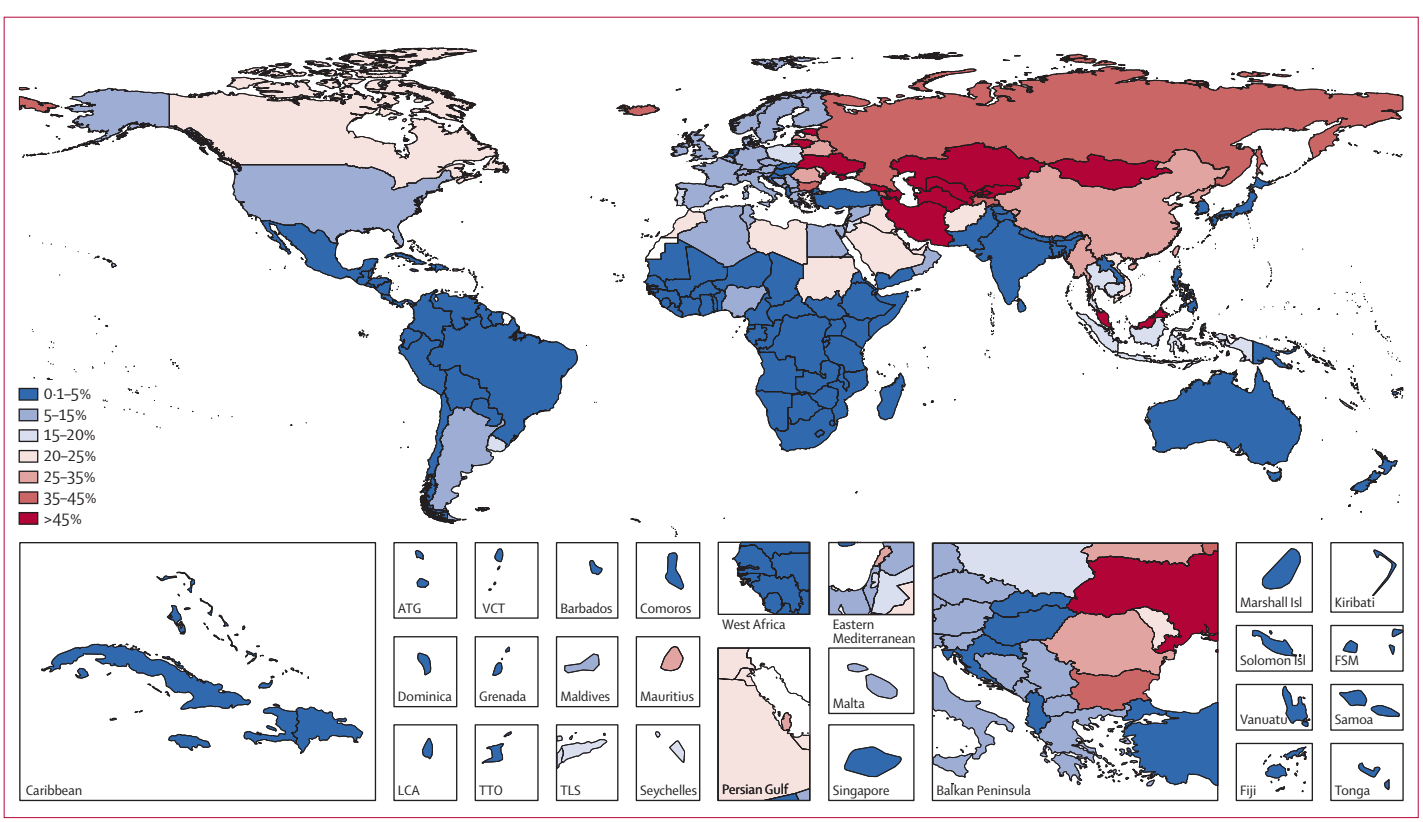

Figure 2: **Proportion of total burden of HIV attributable to injecting drug use by country, 2013**
ATG=Antigua and Barbuda. VCT=Saint Vincent and the Grenadines. LCA=Saint Lucia. TTO=Trinidad and Tobago. TLS=Timor-Leste. FSM=Federated States of Micronesia.

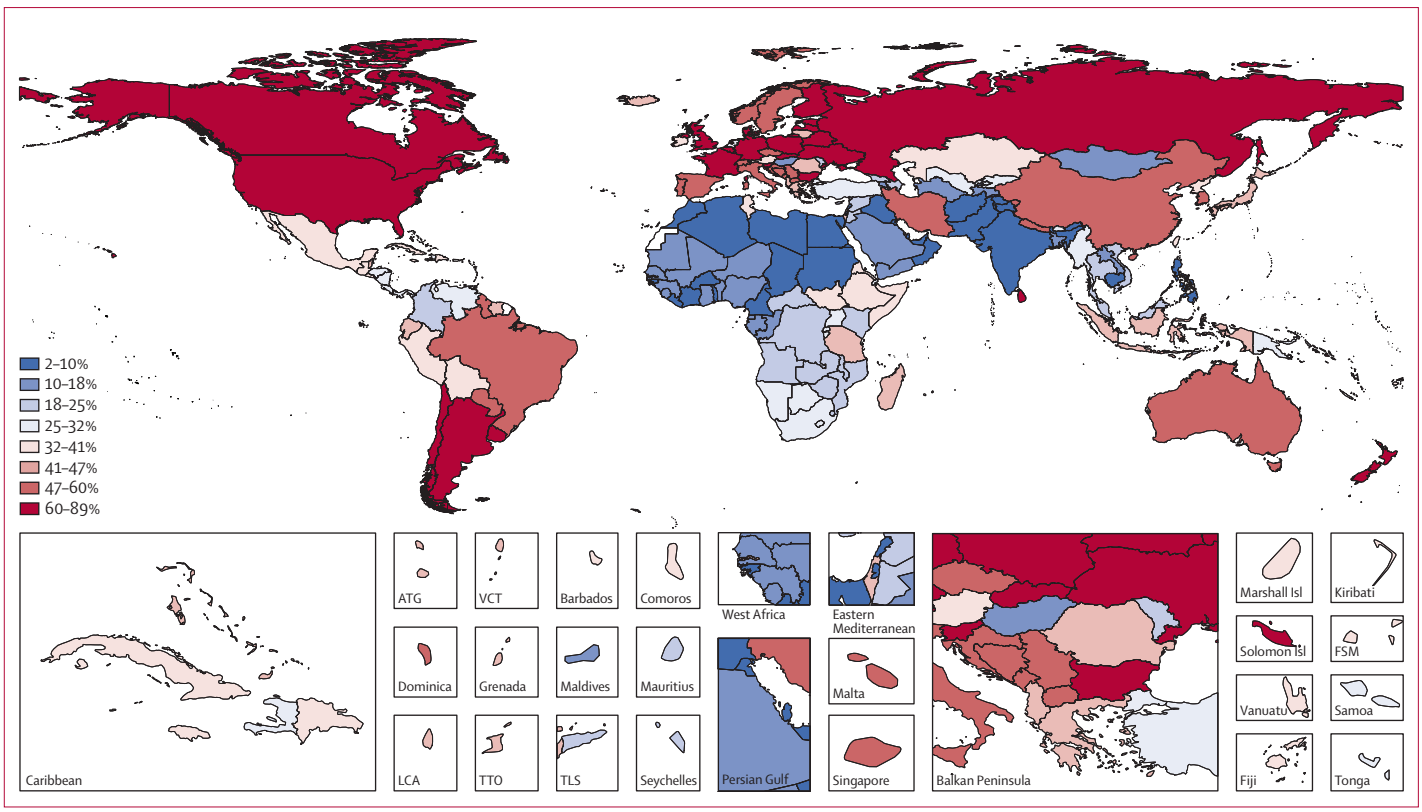

Figure 3: **Proportion of total burden of hepatitis C virus attributable to injecting drug use by country, 2013**
ATG=Antigua and Barbuda. VCT=Saint Vincent and the Grenadines. LCA=Saint Lucia. TTO=Trinidad and Tobago. TLS=Timor-Leste. FSM=Federated States of Micronesia.

DALYs (table 2). In women, IDU was the cause of 2·2% of HIV DALYs, 22·5% of HCV DALYs, and 0·8% of HBV DALYs.

In 2013, the highest age-standardised DALY rates for HIV attributable to IDU were in eastern Europe and sub-Saharan Africa. The greatest population attributable fractions for HIV were in central Asia (64%), eastern Europe (44%), and east Asia (26%; table 1).

We assessed population attributable fraction of IDU as a risk factor for HIV (figure 2), HCV (figure 3), and HBV (figure 4) by country. Country-level DALYs and DALY rates and population attributable fractions for all IDU-attributable burden and burden for HIV, HBV, and HCV are reported in detail in the appendix (pp 107–14). The contribution of IDU to burden varied by country (figures 2, 3, and 4). For HIV, the countries in which IDU accounted for the greatest proportion of HIV burden were in Asia and eastern Europe (figure 2). Countries in which we estimated that at least 60% of HIV burden was attributable to IDU included Iran, Azerbaijan, Kyrgyzstan, Uzbekistan, Malaysia, Kazakhstan, Turkmenistan, and Georgia. Countries in which the estimated contribution of IDU to HCV burden was highest were Canada, the USA, Denmark, and New Zealand (figure 3). IDU made a small contribution to HBV burden in all countries (figure 4).

Discussion

Globally, in 2013, more than 10 million DALYs were estimated to be attributable to previous exposure to HIV, HBV, and HCV via IDU. This represents a four-times increase in DALYs since 1990. Most of this burden was due to YLLs. The majority of attributable burden was due to HCV infection and its consequences. HCV burden attributable to IDU was more than 2·5 times the burden of HIV attributable to injecting.

The contribution that IDU was estimated to have made to the burden of disease varied substantially between different geographic regions. Contributions of IDU to HIV burden were highest in low-to-middle-income countries, whereas the contributions of IDU to HCV burden were highest in high-income countries.

Effective and cost-effective interventions are available to reduce the burden of all three blood-borne viral infections. Efficacious treatments for HIV have been available for 20 years, but coverage among people who inject drugs is negligible.[3,41] The recent development of much more effective and less toxic drugs to treat HCV infection should substantially improve what have previously been extremely low rates of treatment for HCV infection among people who inject drugs.[42,43] Cure rates of 90% or more can be achieved by 8–24 weeks of oral tablets for all HCV genotypes, including in people with cirrhosis or who have

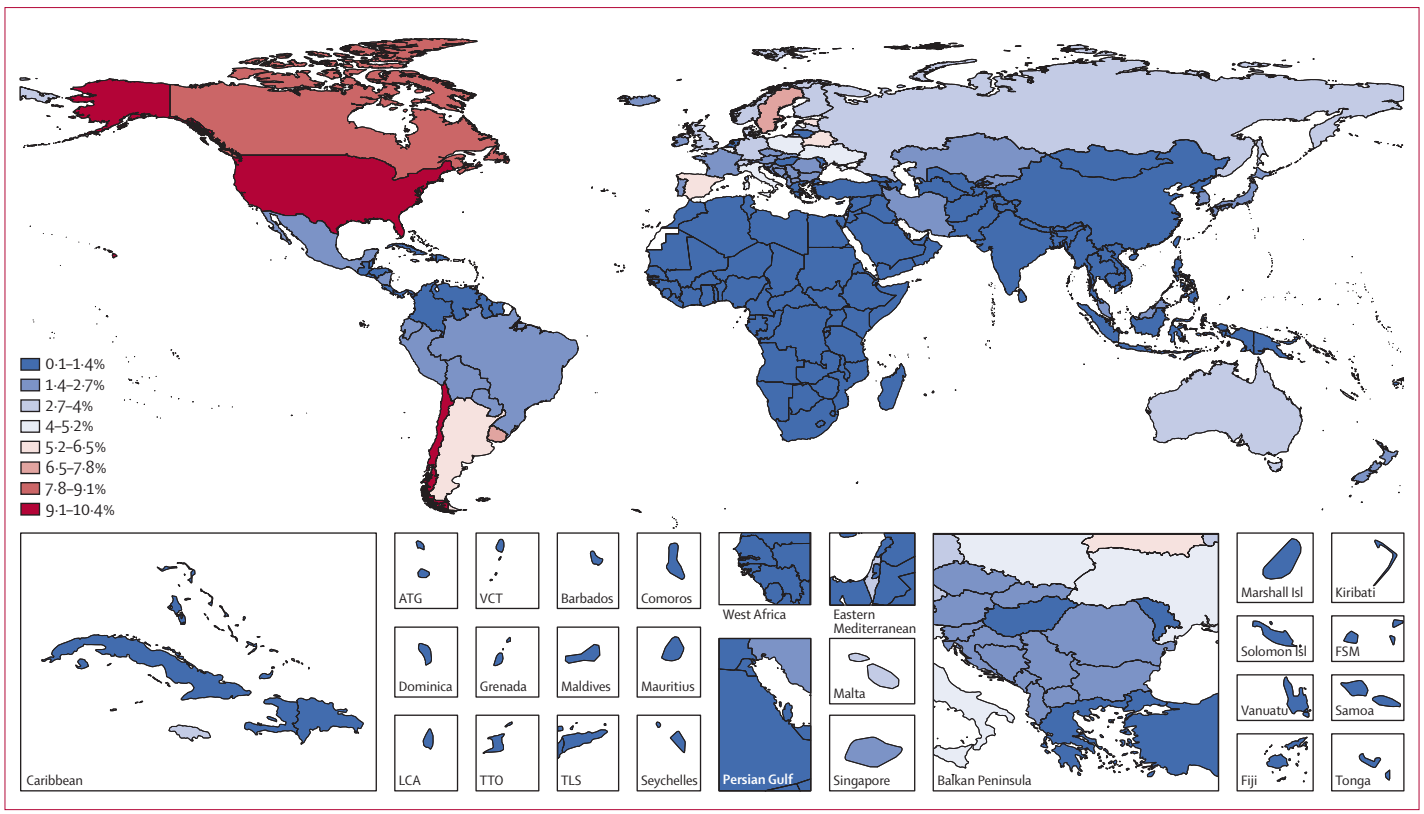

Figure 4: **Proportion of total burden of hepatitis B virus attributable to injecting drug use by country, 2013**
ATG=Antigua and Barbuda. VCT=Saint Vincent and the Grenadines. LCA=Saint Lucia. TTO=Trinidad and Tobago. TLS=Timor-Leste. FSM=Federated States of Micronesia.

co-infection with HIV.[44] These agents represent a therapeutic revolution. There have been limited efforts to increase access in low resource settings, and access to generic versions of several of these antivirals typically remains very low in many countries. The situation is similar for chronic HBV infection, for which highly potent and well tolerated oral agents[45] that suppress viral replication have been available for more than a decade.[46] Access to these drugs remains low in many countries, despite the widespread availability of one antiviral (tenofovir) in combination antiretroviral regimens for HIV treatment. Further efforts are needed to ensure access to these essential medicines in low-resource settings, especially in countries in which people who inject drugs have less access to health-care systems.

Barriers to treatment include low diagnosis rates, unwarranted restrictions on treatment access, and medicine costs.[47] Case-finding, referral, and active management are crucial for the prevention of morbidity in people with a history of IDU. In the USA, there have been recommendations for birth cohort screening, which is controversial, and in the USA is only cost-effective when levels of infection in the general community are higher than 1–2%.[48–50] Few trials have investigated case-finding for people with a history of IDU in low-income and middle-income countries.

Good evidence also exists for the effectiveness of prevention of HIV, HBV, and HCV. Much of the burden attributable to HIV could be averted by scaling up of needle and syringe programmes and provision of opioid substitution treatment and antiretroviral therapy.[30,40,51,52] Increasing HCV burden could also be reduced by expansion of needle and syringe programmes and opioid substitution therapy.[30,53] Findings from systematic reviews have shown that injecting risk and HIV incidence are reduced by the provision of opioid substitution therapy to opioid-dependent injecting drug users.[54,55] However, in many countries, coverage of these interventions is very low among people who inject drugs.[3] The curative, short-course nature of new HCV treatments means that treatment scale-up might produce secondary prevention benefits,[43] although this has yet to be tested empirically.[56] Additionally, there is increasing recognition of the potential of HIV and HCV treatment to prevent infection,[40,43,53] reinforcing the importance of scale-up of these treatments to people with HIV and HCV infection to reduce future transmission.

Infant vaccination and antenatal screening programmes are essential to the prevention of chronic of HBV infection in most countries; if implemented successfully, these approaches would reduce incidence HBV infection in people who subsequently inject drugs. Selective vaccination

programmes against HBV among injecting drug users in countries with low endemic rates of HBV have often had low uptake because of the difficulty of reaching the most at-risk individuals.[57] Correctional facilities provide one opportunity to vaccinate, treat, and reduce the transmission of viral hepatitis in countries in which there are high levels of IDU, HBV, and HCV,[39,58] because many prisoners cycle in and out of the community. However, given the small contribution of IDU to HBV burden, the overall effect of HBV vaccination in prisoners who inject drugs is likely to be small at the population level.

The overall GBD project has limitations that have been discussed in detail in previous studies.[2,8,9,13,59,60] These limitations relate to gaps in data, variable quality of the data that do exist, controversies over the methods used to generate the disability weights that are applied to estimate non-fatal disease burden, and in the modelling that is used to generate internally consistent disease-specific models.

A range of limitations specific to this study also exist. The limited amount of data on the population-level exposure (IDU) and the risk of HIV, HBV, and HCV infection in people who inject drugs generates uncertainty in our estimates. This uncertainty is especially marked in some countries, such as those in Africa, where few data exist on IDU and the incidence and prevalence of infection. There is therefore substantial variation in the uncertainty around the estimates we have made across countries. In the case of countries for which there were no country-specific data inputs into the models, the levels imputed might vary from actual levels. It is unclear whether there would be systematic bias either upwards or downwards in these estimates. Given that the GBD project is ongoing, however, to the extent that new data are collected and may be included to inform models, the estimates made in future iterations will have less uncertainty.

For more on **JS's declaration of interests** see http://www.kcl.ac.uk/ioppn/depts/addictions/people/hod.aspx

We extrapolated exposure to IDU before 1990 for the purposes of generating estimates of historical exposure to HBV and HCV via injection. Substantial uncertainty exists in this modelling because there are few data on trends in the prevalence of IDU and exposure to blood-borne viruses before 1990.

We attributed all excess infections among people who inject drugs to their IDU. For HIV, the proportion of infections due to sexual risk and injecting risk can vary among countries.[61] Nonetheless, in our analyses, most HIV infections were attributed to IDU, and we were not able to take account of the role of exposure via multiple transmission routes. Additionally, we assumed a uniform average risk of infection with HCV and HBV during active injecting periods, whereas some people who inject drugs are at greater risk of exposure than are others.

IDU is a major contributor to the global burden of disease due to infection with blood-borne viruses. Scale-up of effective interventions is needed to prevent and treat these important causes of health burden among people who inject drugs. With HBV and HCV now estimated to cause more deaths globally than HIV infection,[1,9] the political and health-care mobilisation that reduced the number of deaths from HIV infection over the past decade must be implemented for viral hepatitis. WHO's draft Global Health Sector Strategy on viral hepatitis, 2016–2021 provides a good blueprint for the elimination of viral hepatitis as a major public health concern by 2030.[62] This strategy sets targets that include 50% of people who inject drugs being covered by harm reduction services by 2020, and 90% of people living with viral hepatitis being diagnosed and 90% of eligible people treated by 2030. Additionally, the 2016 Political Declaration on HIV and AIDS reaffirmed countries' intention to combat HIV and AIDS by scaling up universal access to prevention, treatment, and care.[63] Both this declaration and the Global Fund acknowledge that treatment of viral hepatitis co-infections is important. Commitment by all countries, and strong engagement across government sectors and with all partners to the response, is crucial to meeting these objectives, which will save millions of lives in coming years.

Contributors

LD and FC worked with the members of the GBD core group, namely TV, JS, and LTA, to perform the epidemiological modelling and prepare the burden estimates. JS did additional modelling of aggregated hepatitis C and hepatitis B burden. LD prepared the first draft of the paper with assistance from FC and SL; all other authors contributed to subsequent drafts. All authors contributed to and approved the final manuscript.

Declaration of interests

LD has received untied educational grants from Reckitt Benckiser and Mundipharma for post-marketing surveillance of new opioid medications in Australia; and by Indivior for work examining naloxone for opioid overdose prevention. MH has received honoraria from Jansen, Gilead, Abbvie, and MSD to present and attend meetings. JS has received funding from Merck; has worked with a range of governmental and non-governmental organisations, and with pharmaceutical companies to explore new or improved treatments from whom he and his employer (King's College London) have received honoraria, travel costs, or consultancy payments; reports grants from Martindale Pharma, Mundipharma, and Braeburn Pharma; has received consultancy payments to his employer for expert advice on product development, trial design, and data analysis from Martindale Pharma, Mundipharma, and Braeburn Pharma; reports a grant from EMCDDA for preparation of a monograph on naloxone; and is named in a patent issued to Euro-Celtique, and contributed to a patent application from King's College London (see online for further details). All other authors declare no competing interests.

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